

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

- 1 1. (Currently amended) A method for communicating between a first
2 semiconductor die and a second semiconductor die through optical signaling,
3 comprising:
4 converting an electrical signal into an optical signal using an electrical-to-
5 optical transducer located on a face of the first semiconductor die, wherein the
6 electrical-to-optical transducer is a member of a plurality of electrical-to-optical
7 transducers associated with a given channel located on the first semiconductor
8 die;
9 ~~passing the optical signal through an interposer sandwiched between the~~
10 ~~first semiconductor die and the second semiconductor die, wherein the interposer~~
11 ~~contains a plurality of waveguides that direct the optical signal, so that the optical~~
12 ~~signal shines on the second semiconductor die, and wherein the plurality of~~
13 ~~waveguides have a pitch less than 50 microns;~~
14 wherein the first semiconductor die and the second semiconductor die are
15 oriented face-to-face so that the optical signal generated on the first
16 semiconductor die shines on the second semiconductor die;
17 receiving the optical signal on a face of the second semiconductor die; and
18 converting the optical signal into a corresponding electrical signal using an
19 optical-to-electrical transducer located on the face of the second semiconductor
20 die, wherein the optical-to-electrical transducer is a member of a plurality of

21 | optical-to-electrical transducers associated with the given channel located on the
22 | second semiconductor die;
23 | whereby a plurality of optical signals can be transmitted in parallel from
24 | the first semiconductor die to the second semiconductor die to correct
25 | misalignments between the first semiconductor die and the second semiconductor
26 | die.

1 2. (Original) The method of claim 1, wherein after generating the optical
2 signal on the first semiconductor die, the method further comprises passing the
3 optical signal through annuli located within metal layers on the first
4 semiconductor die to focus the optical signal onto the second semiconductor die.

1 3. (Original) The method of claim 1, wherein after generating the optical
2 signal on the first semiconductor die, the method further comprises using a lens to
3 focus the optical signal onto the second semiconductor die.

1 4. (Original) The method of claim 1, wherein after generating the optical
2 signal on the first semiconductor die, the method further comprises using a mirror
3 to reflect the optical signal, so that the optical signal can shine on the second
4 semiconductor die without the first semiconductor die having to be coplanar with
5 the second semiconductor die.

1 5-6 (Canceled).

1 | 7. (Currently amended) The method of claim 1-~~claim 6~~,
2 wherein multiple spatially adjacent electrical-to-optical transducers in the
3 plurality of electrical-to-optical transducers transmit the same signal; and

4 wherein electronic steering circuits in the first semiconductor die direct
5 data to the multiple spatially adjacent electrical-to-optical transducers to correct
6 mechanical misalignment in X , Y and θ coordinates.

1 8. (Currently amended) The method of claim 1-~~claim 6~~,
2 wherein multiple spatially adjacent optical-to-electrical transducers in the
3 plurality of optical-to-electrical transducers receive the same signal; and
4 wherein electronic steering circuits in the second semiconductor die direct
5 data from the multiple spatially adjacent optical-to-electrical transducers to correct
6 mechanical misalignment in X , Y and θ coordinates.

1 9. (Original) The method of claim 1, wherein the electrical-to-optical
2 transducer includes one of:
3 a Zener diode;
4 a light emitting diode (LED);
5 a vertical cavity surface emitting laser (VCSEL); and
6 an avalanche breakdown P-N diode.

1 10. (Original) The method of claim 1, wherein the optical-to-optical
2 transducer includes one of:
3 a P-N-diode photo-detector; and
4 a P-I-N-diode photo-detector.

1 11. (Currently amended) An apparatus for communicating between
2 semiconductor chips through optical signaling, comprising:
3 a first semiconductor die;
4 a second semiconductor die;

5 an electrical-to-optical transducer located on a face of the first
6 semiconductor die, which is configured to convert an electrical signal into an
7 optical signal, wherein the electrical-to-optical transducer is a member of a
8 plurality of electrical-to-optical transducers associated with a given channel
9 located on the first semiconductor die;
10 wherein the first semiconductor die and the second semiconductor die are
11 oriented face-to-face so that the optical signal generated on the first
12 semiconductor die shines on the second semiconductor die;
13 an optical-to-electrical transducer located on a face of the second
14 semiconductor die, which is configured to convert the optical signal received from
15 the first semiconductor die into a corresponding electrical signal, wherein the
16 optical-to-electrical transducer is a member of a plurality of optical-to-electrical
17 transducers associated with the given channel located on the second
18 semiconductor die;
19 whereby a plurality of optical signals can be transmitted in parallel from
20 the first semiconductor die to the second semiconductor die to correct
21 misalignments between the first semiconductor die and the second semiconductor
22 die; and
23 ~~an interposer sandwiched between the first semiconductor die and the~~
24 ~~second semiconductor die, wherein the interposer contains a plurality of~~
25 ~~waveguides that direct the optical signal, so that the optical signal shines on the~~
26 ~~second semiconductor die, and wherein the plurality of waveguides have a pitch~~
27 ~~less than 50 microns.~~

1 12. (Original) The apparatus of claim 11, further comprising annuli located
2 within metal layers on the first semiconductor die configured to focus the optical
3 signal onto the second semiconductor die.

1 13. (Original) The apparatus of claim 11, further comprising a lens
2 configured to focus the optical signal onto the second semiconductor die.

1 14. (Original) The apparatus of claim 11, further comprising a mirror
2 configured to reflect the optical signal, so that the optical signal can shine on the
3 second semiconductor die without the first semiconductor die having to be
4 coplanar with the second semiconductor die.

1 15-16 (Canceled).

1 | 17. (Currently amended) The apparatus of claim 11 ~~claim 16~~,
2 wherein multiple spatially adjacent electrical-to-optical transducers in the
3 plurality of electrical-to-optical transducers transmit the same signal; and
4 wherein electronic steering circuits in the first semiconductor die direct
5 data to the multiple spatially adjacent electrical-to-optical transducers to correct
6 mechanical misalignment in X , Y and Θ coordinates.

1 | 18. (Currently amended) The apparatus of claim 11 ~~claim 16~~,
2 wherein multiple spatially adjacent optical-to-electrical transducers in the
3 plurality of optical-to-electrical transducers receive the same signal; and
4 wherein electronic steering circuits in the second semiconductor die direct
5 data from the multiple spatially adjacent optical-to-electrical transducers to correct
6 mechanical misalignment in X , Y and Θ coordinates.

1 19. (Original) The apparatus of claim 11, wherein the electrical-to-optical
2 transducer includes one of:

- 3 a Zener diode;
4 a light emitting diode (LED);

5 a vertical cavity surface emitting laser (VCSEL); and
6 an avalanche breakdown P-N diode.

1 20. (Original) The apparatus of claim 11, wherein the optical-to-optical
2 transducer includes one of:

3 a P-N-diode photo-detector; and
4 a P-I-N-diode photo-detector.

1 21. (Currently amended) A computer system including semiconductor
2 chips that communicate with each other through optical signaling, comprising:
3 a first semiconductor die containing one or more processors;
4 a second semiconductor die containing circuitry that communicates with
5 the one or more processors;

6 an electrical-to-optical transducer located on a face of the first
7 semiconductor die, which is configured to convert an electrical signal into an
8 optical signal, wherein the electrical-to-optical transducer is a member of a
9 plurality of electrical-to-optical transducers associated with a given channel
10 located on the first semiconductor die;

11 wherein the first semiconductor die and the second semiconductor die are
12 oriented face-to-face so that the optical signal generated on the first
13 semiconductor die shines on the second semiconductor die;

14 an optical-to-electrical transducer located on a face of the second
15 semiconductor die, which is configured to convert the optical signal received from
16 the first semiconductor die into a corresponding electrical signal, wherein the
17 optical-to-electrical transducer is a member of a plurality of optical-to-electrical
18 transducers associated with the given channel located on the second
19 semiconductor die;

20 whereby a plurality of optical signals can be transmitted in parallel from
21 the first semiconductor die to the second semiconductor die to correct
22 misalignments between the first semiconductor die and the second semiconductor
23 die; and
24 ~~an interposer sandwiched between the first semiconductor die and the~~
25 ~~second semiconductor die, wherein the interposer contains a plurality of~~
26 ~~waveguides that direct the optical signal, so that the optical signal shines on the~~
27 ~~second semiconductor die, and wherein the plurality of waveguides have a pitch~~
28 ~~less than 50 microns.~~

1 22. (Original) The computer system of claim 21, further comprising annuli
2 located within metal layers on the first semiconductor die configured to focus the
3 optical signal onto the second semiconductor die.

1 23. (Original) The computer system of claim 21, further comprising a lens
2 configured to focus the optical signal onto the second semiconductor die.

1 24. (Original) The computer system of claim 21, further comprising a
2 mirror configured to reflect the optical signal, so that the optical signal can shine
3 on the second semiconductor die without the first semiconductor die having to be
4 coplanar with the second semiconductor die.

1 25-26 (Canceled).

1 27. (Currently amended) The computer system of claim 21 ~~claim 26~~,
2 wherein multiple spatially adjacent electrical-to-optical transducers in the
3 plurality of electrical-to-optical transducers transmit the same signal; and

4 wherein electronic steering circuits in the first semiconductor die direct
5 data to the multiple spatially adjacent electrical-to-optical transducers to correct
6 mechanical misalignment in X , Y and θ coordinates.

1 28. (Currently amended) The computer system of claim 21-~~claim 26~~,
2 wherein multiple spatially adjacent optical-to-electrical transducers in the
3 plurality of optical-to-electrical transducers receive the same signal; and
4 wherein electronic steering circuits in the second semiconductor die direct
5 data from the multiple spatially adjacent optical-to-electrical transducers to correct
6 mechanical misalignment in X , Y and θ coordinates.

1 29. (Original) The computer system of claim 21, wherein the electrical-to-
2 optical transducer includes one of:
3 a Zener diode;
4 a light emitting diode (LED);
5 a vertical cavity surface emitting laser (VCSEL); and
6 an avalanche breakdown P-N diode.

1 30. (Original) The computer system of claim 21, wherein the optical-to-
2 optical transducer includes one of:
3 a P-N-diode photo-detector; and
4 a P-I-N-diode photo-detector.

1 31. (New) The method of claim 1, wherein after generating the optical
2 signal on the first semiconductor die, the method further comprises passing the
3 optical signal through an interposer sandwiched between the first semiconductor
4 die and the second semiconductor die, wherein the interposer contains one or

5 more waveguides that direct the optical signal, so that the optical signal shines on
6 the second semiconductor die.

1 32. (New) The apparatus of claim 11, further comprising an interposer
2 sandwiched between the first semiconductor die and the second semiconductor
3 die, wherein the interposer contains one or more waveguides that direct the optical
4 signal, so that the optical signal shines on the second semiconductor die.

1 33. (New) The computer system of claim 21, further comprising an
2 interposer sandwiched between the first semiconductor die and the second
3 semiconductor die, wherein the interposer contains one or more waveguides that
4 direct the optical signal, so that the optical signal shines on the second
5 semiconductor die.